

**REMARKS**

This amendment responds to the Office Action mailed on August 11, 2004. Filed concurrently herewith is a *Request for a Three Month Extension of Time* which extends the shortened statutory period for response to expire on February 11, 2005. Accordingly, Applicants respectfully submit that this response is being timely filed.

Claims 1-18 were pending. In the Office Action mailed August 11, 2004, amendments to the specification and drawings were either suggested or required. Applicants have so amended the specification and drawings. Accordingly, claims 1-18 remain pending in the present application, and Applicant believes these claims are in proper condition for allowance for the reasons set forth below.

**Priority**

In accordance with the suggestions in paragraph 1 of the Office Action, the specification has been amended above to reference that the present application is a continuation of pending PCT Application No. PCT/GB99/03168, filed October 11, 1999, which is incorporated by reference in its entirety herein, and claims priority to U.S. Provisional Patent Application No. 60/115,952 filed on January 14, 1999, now abandoned, which is incorporated by reference in its entirety herein, and claims priority to GB Patent Application No. 9822075.9, filed October 10, 1998, now abandoned, which is incorporated by reference in its entirety herein. A copy of the certified priority document for (GB) 9822075.9 is also submitted herewith.

It should be noted that the present application claims priority to GB Patent Application No. 9822075.9 filed October 10, 1998. Further, the present application is the U.S. national stage application of PCT Application No. PCT/GB99/03168. When filing the present application, Applicant inadvertently indicated on the transmittal page filed with the present application that it was a continuation-in-part of PCT/GB99/03168. However, the present application is actually a continuation of PCT Application No. PCT/GB99/03168 as its U.S. national stage application. Thus, the effective priority date of the present application is the October 10, 1998 filing date of GB Patent Application No. 9822075.9. As can be seen from the copy of the certified priority document for GB Patent Application No. 9822075.9 submitted concurrently herewith, the disclosure in the specification of the present application is identical to and fully supported by GB

**Amendments to the Drawings**

In response to the objections to the drawings, Applicant has submitted herewith Replacement Sheets for Figs 5-7 to the drawings to eliminate the use of the numerals 1, 2 and 3 to designate intermediate representation blocks in Figures 6 and 7. In particular, the numerals 100, 200 and 300 have been respectively substituted for 1, 2 and 3 in Fig. 6. In Fig. 7, the numerals 100, 200a, 200b and 300 have been respectively substituted for the numerals 1, 2a, 2b and 3.

Patent Application No. 9822075.9. Hence, the present application has an effective priority date of October 10, 1998.

### **Drawings**

Paragraph 4 of the Office Action objected to the drawings as failing to comply with 37 CFR 1.84(p)(4). With respect to the objections to FIGS. 1-6, Applicant has submitted herewith Replacement Sheets for Figs 5-7 to the drawings to eliminate the use of the numerals 1, 2 and 3 to designate intermediate representation blocks in Figures 6 and 7. In particular, the numerals 100, 200 and 300 have been respectively substituted for 1, 2 and 3 in Fig. 6. In Fig. 7, the numerals 100, 200a, 200b and 300 have been respectively substituted for the numerals 1, 2a, 2b and 3. The specification has been amended accordingly to reflect these changes to the reference numerals.

Paragraph 5 of the Office Action object to the drawings as failing to comply with 37 CFR 1.84(p)(5). Initially, it is asserted in the Office Action that characters 1-12 in FIGS. 1-5 are not mentioned in the description. It is clearly described on page 18, lines 21-25 of the specification of the present application that FIGS. 1-5 show the step by step progression of how the intermediate representation is generated. Reference numerals 1-12 indicate the incremental progression of the steps in generating the intermediate representation, where each of the 12 steps in the illustrative example are identified by the reference numerals 1-12 appearing in FIGS. 1-5. These steps are further clearly described in the following pages 19-21 of the specification. By the above amendment, Applicant has amended the specification to make clear reference to numerals 1-12 appearing in the figures, and it is respectfully submitted that such changes do not add any new subject matter to the present application.

Paragraph 5 of the Office Action further indicates that the 'expression forest' described in the specification is not labeled in any of FIGS. 1 to 5. Applicant notes that FIGS. 1 to 5 together illustrate the 'expression forest,' as described on page 15, 8<sup>th</sup> paragraph of the specification. All of the expression trees referenced by each of the register objects together form the 'expression forest,' as described on page 3, lines 19-21 of the specification. Thus, it can be seen that the 'expression forest' changes as more expression trees are generated in the progression through

FIGS. 1 to 5. Thus, FIGS. 1 to 5 as a whole are the expression forest and this is clearly referenced and described in the specification. Reconsideration is respectfully requested.

### **Provisional Double-Patenting Rejections**

Paragraphs 8 and 9 of the Office Action provisionally rejected claims 1-18 under 35 U.S.C. § 101 as claiming the same subject matter of that of claims 1-18 of co-pending Applications Nos. 10/164,772 and 10/165,378. Applicants respectfully submit that this double patenting rejection is moot since preliminary amendments canceling Claims 1-18 were filed in each of these co-pending applications. Accordingly, Applicant respectfully requests withdrawal of the rejection.

### **Claim Rejections Under 35 U.S.C. §102**

Paragraph 11 of the Office Action rejects claims 1-3, 5-7, 12, 14 and 16-18 under U.S.C. § 102(b) as anticipated by Aho et al., “Compiler, principles, techniques, and tools” book, published in 1986 (hereinafter “Aho”). Applicant respectfully traverses this rejection and submits that the claims at issue are patentable over those patents for the following reasons.

#### **CLAIMS 1-3, 5-7, 12, 14 and 17**

Claims 1-3, 5-7, 12, 14 and 17 are directed to a method and apparatus for generating an intermediate representation (IR) of program code by generating: i) a plurality of register objects representing abstract registers, and ii) expression object each representing a different element of the program code and being referenced by a register object to which it relates either directly, or indirectly via references from other expression objects. According to a pertinent aspect of Applicant’s disclosure to which these claims are directed, “abstract registers” are generated to reference expressions derived from the code being translated. The intermediate representation for the translation of the program code is improved by using “abstract register” objects, one per subject register, to hold the roots of expressions used to update registers.

According to one aspect of Applicant’s method of generating an intermediate representation, a plurality of register objects representing abstract registers are generated to reference different expression objects. Each expression object is referenced by the register

objects to which it either directly or indirectly relates. Referring to page 3, last 2 paragraphs of the specification of the present application, Applicant describes that an advantage of this aspect of Applicant's method is that any given expression object may be referenced to more than one register object. Consequently, an expression which is used by several different registers is not required to be created and assigned to each of those register objects separately, but may be created once and referenced to each of the register objects. In other words, expression trees may be linked together by expression objects which are referenced by more than one register object. By avoiding making multiple copies of the same expression, Applicant's method reduces the time required to create the intermediate representation and reduces the memory space occupied by the intermediate representation.

Applicant further describes on page 4 of the specification that another advantage of Applicant's above-described method is that expressions that become redundant can be efficiently identified. This allows redundant code to be located and eliminated efficiently in accordance with Applicant's teachings on page 4 of the specification.

Referring to Aho, and particularly to pages 517 and 558-559 cited by the Office Action, there is no disclosure of the concept of generating register objects representing "abstract registers." Rather, when Aho refers to the term "register," Aho is referring to a physical register implemented in the CPU that runs the code that Aho is compiling. Aho's description of allocating and assigning registers concerns physical registers, not register objects representing abstract registers in the intermediate representation. In contrast, the use of the term "abstract registers" in Applicant's claims reference expressions derived from the code being translated. There is no teaching or suggestion in Aho that register objects are actually formed in the intermediate representation, nor is the concept of an abstract register addressed in Aho. The Office Action refers to Fig. 9.18 in Aho in asserting that each of the t1, t2, t3, t4 are 'expression objects.' Applicant notes that no register objects representing "abstract registers" are taught or suggested in Aho's dag representation in Fig. 9.18.

According to the Examiner's assertion that each of the t1, t2, t3, t4 are 'expression objects,' none of these objects are referenced by a register object, as recited in the claims of the present application. In Aho's dag representation in Fig. 9.18, the variables a<sub>0</sub> and b<sub>0</sub> are

referenced by t1. However, the expression object t1 is only referenced by another expression object t4. There are no expression objects (t1, t2, t3, t4) being referenced by register objects representing abstract registers.

Clearly, Aho fails to teach or suggest the expression objects “being referenced by a register object” as recited in claims 1-3, 5-7, 12, 14 and 17 of the present application. Since claims 1-3, 5-7, 12, 14 and 17 clearly recite generating register objects corresponding to respective abstract registers where each expression object generated is referenced by an abstract register to which it relates, these claims are clearly not anticipated by Aho. Accordingly, Applicant respectfully submits that the Section 102 rejection of claims 1-3, 5-7, 12, 14 and 17 should be withdrawn and these claims allowed.

#### CLAIM 5

More specifically with reference to dependent claim 5, Applicant notes that the phrase “feeds into” is incorrectly being used in the inverse sense in the Office Action. Claim 5 recites that at least some expression objects “feed into” more than one register object. As shown in FIGS. 1-5, an object at the end of a directional arrow linking two objects will “feed into” the other object. It can be seen that the expression objects are at the end of the directional arrows and feed into the register objects (R0-R5). Applying this proper interpretation of claim 5 to Fig. 9.18 of Aho would, for example, result in the objects a<sub>0</sub> and b<sub>0</sub> “feeding into” t1. In other words, the variables a<sub>0</sub> and b<sub>0</sub> are referenced by t1. Clearly, it can be seen that t1, t2, t3, t4 of Fig. 9.18 of Aho (i.e., the objects alleged to correspond to the expression objects of claim 5) do not feed into any register objects. At best, Aho teaches that such expression objects feed into other expression objects. Accordingly, Applicant respectfully submits that dependent claim 5 is separately patentable over the cited prior art and the Section 102 rejection of claim 5 should be withdrawn.

#### CLAIM 7

Referring more specifically to dependent claim 7, this claim recites that only a single expression object is generated for a given element of program code and that each expression object is referenced by all register objects to which it relates. The Office Action does not point to any specific portions of Aho that teach or suggest these limitations of claim 7 but rather just

refers to Aho in general. Applicant respectfully submits that Aho fails to teach creating an expression only once and referencing the expression to all register objects to which it relates. As described above, this aspect of Applicant's method eliminates the need for an expression which is used by several different registers to be created and assigned to each of those register objects separately, but may be created once and referenced to each of the register objects. This feature is not taught or suggested by Aho, and Applicant respectfully submits that dependent claim 5 is separately patentable over Aho and requests that the Section 102 rejection of claim 7 be withdrawn.

### CLAIMS 16 AND 18

Initially, Applicant asserts that claims 16 and 18 are patentable over Aho for the same reasons set forth above in that Aho fails to teach or suggest actually generating register objects in an intermediate representation for holding variable values. Thus, the advantages achieved by the Applicant's method and apparatus of identifying and eliminating redundant code are not readily apparent from the teachings of Aho. Still further, independent claims 16 and 18 recite, *inter alia*, that the generated objects in the intermediate representation are organized into a branched-tree like network having all register objects at the lowest basic root or tree-trunk level of the network with no register object feeding into another register object. Referring to FIGS. 1-5 of the present application, it can be seen that each of the register objects (R0, R1, R2, R3, R4, R5) at the top of the figures all serve as the lowest basic root of all of the branched-like tree networks extending therefrom. It can also be seen that no register objects (R0, R1, R2, R3, R4, R5) feed into another object. Aho does not teach this feature. In contrast, it is asserted in the Office Action (page 12, 1st paragraph) that objects  $a_0$  and  $b_0$  correspond to Applicant's claimed register objects. However, it can be seen that objects  $a_0$  and  $b_0$  do not serve as the lowest basic root of all of the branched-like tree networks because they feed into expression object t1. Thus, Aho does not teach or suggest that generating an intermediate representation "having all register objects at the lowest basic root or tree-trunk level of the network with no register object feeding into another register object."

Since Aho does not disclose or teach, either expressly or inherently, generating an intermediate representation having all register objects at the lowest basic root or tree-trunk level of the network with no register object feeding into another register object, it necessarily follows that the rejection of claims 16 and 18 under 35 U.S.C. § 102(b) cannot be sustained. Applicants respectfully submit that the rejection of claims 16 and 18 should be withdrawn.

### **Claim Rejections Under 35 U.S.C. §103**

Paragraph 13 of the Office Action rejects claims 4, 8-11 and 13 under U.S.C. § 103(a) as being obvious over Aho in view of U.S. Patent No. 6,463,582. Applicant respectfully traverses this rejection and submits that the claims at issue are patentable over those patents for the following reasons.

Applicant notes that it is admitted in the Office Action that Aho fails to teach or suggest the limitations recited in 4, 8-11 and 13, where the Lethin patent is relied upon in the Office Action for teaching these features. As set forth above, the present application claims priority to GB Patent Application No. 9822075.9 and has an effective priority date of the October 10, 1998 filing date of GB Patent Application No. 9822075.9. It can be seen from the copy of the certified priority document submitted concurrently herewith that GB Patent Application No. 9822075.9 fully supports the claims in the present application. The Lethin patent was not filed until October 21, 1998, after the effective priority date of the present application. Thus, the Lethin patent is not prior art to the present application and all rejections in the Office Action relying upon the teachings the Lethin patent should be removed. Applicants respectfully submit that the rejection of claims 4, 8-11 and 13 should be withdrawn.




Conclusion

In view of the foregoing remarks and amendments, Applicants respectfully submit that the subject application is in condition for allowance. Applicants, therefore, respectfully request reconsideration and early notice of allowance.

Respectfully submitted,

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